Capturing System Intentionality with Maps

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Abstract. Conceptual modelling has emerged as a means to capture the relevant aspects of the world on which it is necessary to provide information. Whereas conceptual models succeeded in telling us how to represent some excerpt of the world in informational terms, they failed to guide system analysts in conceptualising purposeful systems, i.e. systems that meet the expectations of their users. This chapter aims to investigate this issue of conceptualising purposeful systems and to discuss the role that goal driven approaches can play to resolve it. It considers the challenge of new systems having a multifaceted purpose and shows how intention/strategy maps help facing this challenge.

1 Introduction

Traditionally Information System (IS) engineering has made the assumption that an information system captures some excerpt of world history and hence has concentrated on modelling information about the Universe of Discourse [43]. This is done through conceptual modelling that aims at abstracting the specification of the required information system i.e. the conceptual schema, from an analysis of the relevant aspects of the Universe of Discourse about which the users' community needs information [9]. This specification concentrates on what the system should do, that is, on its functionality. Such a specification acts as a prescription for system construction. Whereas conceptual modelling allowed our community to understand the semantics of information and led to a large number of semantically powerful conceptual models [23] and associated tools [20], experience demonstrates that it failed in supporting the delivery of systems that were accepted by the community of their users. Indeed, a number of studies show [11, 24, 41] that systems fail due to an inadequate or insufficient understanding of the requirements they seek to address. Further, the amount of effort needed to fix these systems has been found to be very high [17]. To correct this situation, it is necessary to address the issue of building *purposeful systems*, i.e. information systems that are seen as fulfilling a certain purpose in an organisation. Understanding this purpose is a necessary condition for the conceptualisation of these purposeful systems. The foregoing suggests to go beyond the functionality based view of conceptual modelling and to extend the '*what is done by the system'* approach with the '*why is the system like this*'. This *why* question is answered in terms of organisational objectives and their impact on information systems supporting the organisation. The expectation is that as a result of a refocus on the *why* question, more acceptable systems will be developed in the future.

The objective of this chapter is to deal with the above issue of conceptualising purposeful systems and to show how a representation system called *Map* can help to this end. Map is a goal-driven approach similar to those developed in requirements engineering [1, 5, 6, 21, 28, 32, 34] business process reengineering [2, 22, 27, 44] and enterprise/business modelling with a holistic viewpoint [26, 38]. In these approaches goal-modelling proved to be an efficient means to capturing the '*Whys'* and establishing a close relationship with the '*Whats*'. The *Map* representation system conforms to goal models in the fact that it recognizes the concept of a goal (intention) but departs from those by introducing the concept of *strategy* to attain a goal. This choice was motivated by:

a) the fundamental distinction between *what to achieve* (the goal) and the *manner to achieve* it (the strategy),
b) *practice*: managers and stakeholders do not naturally make this distinction
c) *pitfalls* generated by this confusion:
    i. strategies are expressed as goals, then unnecessarily increasing the size of the goal model,
    ii. alternative ways to make the business are more difficult to discover whereas reasoning about alternative ways of achieving a goal is easier,
    iii. recognizing stable elements in a business (intentions) versus more versatile ones (strategies) is difficult.
d) the *need to introduce variability* in the new generation of information systems. Whereas earlier, a system met the purpose of a single organization and of a single set of customers, a system of today must be conceived in a larger perspective, to meet the purpose of several organizations and to be adaptable to different usage situations and customer sets. The former is typical of an ERP-like de-

velopment situation whereas the latter is the concern of product-line development [4, 42] and adaptable software. In the software community, this leads to the notion of software variability which is defined as the ability of a software system to be changed, customized or configured to a specific context [13]. Whereas the software community studies variability as a design problem and concentrates on implementation issues [3, 26, 42], we believe like [14] that capturing variability at the goal level is essential to meet the multi-purpose nature of new information systems.

e) *the essential role of strategies in capturing variability in goal models*: Whereas traditional goal modelling concentrates on goal discovery, variability extends it to consider the many different ways of goal achievement For example, for the goal *Purchase Material*, earlier it would be enough to know that an organization achieves this goal by forecasting material need. Thus, *Purchase Material* was mono-purpose: it had exactly one strategy for its achievement. However, in the new context, it is necessary to introduce other strategies as well, say the Reorder Point strategy for purchasing material. *Purchase Material* is multi-purpose: it has many strategies for goal achievement. Our position is that variability implies a move from systems with a *mono-facetted purpose* to those with a *multi-facetted purpose* and points to the need to balance *goal-orientation* with the introduction of *strategies for goal achievement.* This is the essence of *intention/strategy maps* which we present here.

An *intention/strategy map*, or *map* for short, is a graph, with nodes as *intentions* and *strategies* as edges. An edge entering a node identifies a strategy that can be used for achieving the intention of the node. The map therefore, shows which intentions can be achieved by which strategies once a preceding intention has been achieved. Evidently, the map is capable of expressing variability in goal achievement and therefore, can help modelling the multi-facetted purpose of a system.

The remainder of this paper is organized in two main sections. The next section presents the *Map* representation system. In section 3 we illustrate the key aspects of *Map* with an excerpt of a real project conducted at DIAC, the financial branch of the Renault motor which grants credit to Renault customers and sells other related financial services. The *Map* approach was used to handle the standardization of practices in the various DIAC subsidiaries located in different countries in the world. In section 4 we conclude by summing up the lessons learnt from using *Map* in different European projects.

2 The *Map* representation system

In this section we introduce the *key concepts* of a map and their relationships and brought out their relevance to capture multi-facetted purposes.

Map is a representation system that was originally developed to represent a process model expressed in intentional terms [35]. It provides a representation mechanism based on a non-deterministic ordering of *intentions* and *strategies* that allows us to modelling the multi-facetted purpose of a system To-Be. The key concepts of the map and their inter-relationships are shown in the map meta-model of Fig.1 which is drawn using standard UML notations.

- A *map* is composed of several sections. A section is an aggregation of two kinds of intentions, *source* and *target*, linked together with a *strategy*.
- An *intention* is a goal that can be achieved by the performance of a process. An intention is according to Jackson [16], 'an optative' statement, it expresses what is wanted, a state or a result that is expected to be reached or maintained in the future. For example, *Make Room Booking* is an intention to make a reservation for a room in a hotel. The achievement of this intention leaves the system in the state, *Booking made.* Each map has two special intentions, *Start* and *Stop*, associated with the initial and final states respectively. We use a linguistic approach to define a template for formulating an intention. Our linguistic approach is inspired by Fillmore's case grammar [12] and its extension by Dik [8]. It views an intention statement as composed of a *verb* and different *parameters* which play specific roles with respect to the verb. The structure of an intention is the following:

  Intention: Verb <Target> [<Parameter>]*

Table 1 summarizes these parameters. In addition to the linguistic template, [29] proposed a classification of verbs and defined for each class, a *verb frame* which indicates the mandatory and optional parameters. For instance, the frame of the verb remain is *remain [Qual,(Ref),(Loc),(Time)].* This frame means that « remain » is always followed by a quality and optionally followed by a referent, a location and a time point.

- A *strategy* is an approach, a manner or a means to achieve an intention. Let us assume that bookings can be made *on the Internet*. This is a way of achieving the room booking intention, i.e. a strategy. *By visiting a travel agency* is another strategy to achieve the same intention. It shall be noticed that the linguistic template for intention wording includes the parameter *way* which specializes into *manner* and *means*. Strategies in the *Map representation system* provide the means to capture variability in intention achievement.

- A *section* is an aggregation of the source intention, the target intention, and a strategy. As shown in Fig. 1 it is a triplet <I_{source}, $I_{target,}$ $S_{source\text{-}target}$>. A section expresses the strategy $S_{source\text{-}target}$ using which, starting from the source intention, I_{source}, the target intention, I_{target} can be achieved. . The triplet <*Start, Make Room Booking, on the Internet*> is a section; similarly <*Start, Make Room Booking, by visiting a travel agency*> constitutes another section.

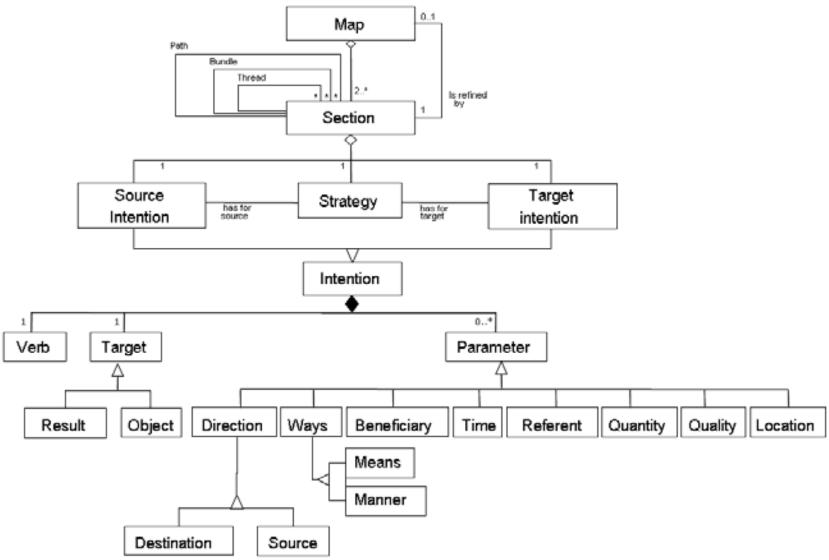

Fig. 1. The map meta-model

A section is the basic construct of a map which itself can be seen as an assembly of sections. When a map is used to model a multi-facetted purpose, each of its sections represents a facet. The set of sections model the purpose in its totality and we will see below that the relationships between sections and between a section and a map lead to the representation of the multi-facetted perspective.

A map section, a facet, highlights a consistent and cohesive characteristic of the system that stakeholders want to be implemented through some functionality. A facet in our terms is close to the notion of feature defined in FODA [19] as a “prominent or distinctive user-visible aspect, quality or characteristic of a system”. However, our view of a facet emphasizes the intention that the underlying functionality allows to achieve. We believe that a facet is a useful abstraction to express variability in intentional terms.

A map is graphically represented as a directed graph from Start to Stop. Intentions are represented as nodes and strategies as edges between these. The graph is directed because the strategy shows the flow from the source to the target intention. The map of Fig. 2 contains six sections/facets MS0 to MS5.

Table 1. The intention parameters

Parameter	Description	Example
Target	The *Target* (Tar) designates an entity affected by the goal. We distinguish two types of target, object and result.	
Object	An *object* (Obj) exists before the goal is achieved.	*‘Check (room availability)* $_{Obj}$ *’*
Result	*Result* (Res) can be of two kinds (a) entity which does not exist before the goal is achieved (b) abstract entity which exists but is made concrete as a result of goal achievement.	(a) *‘Make (room booking)* $_{Res}$ *’* (b) *‘Define (customer’s request)* $_{Res}$ *’*
Source	The two types of *direction* (Dir), namely s*ource* (So) and *destination* (Dest) identify respectively, the initial and final location of objects to be communicated.	*‘Read (the validity date of card)* $_{Obj}$ *(in the card chip)* $_{So}$ *’*
Destination		*‘Offer (booking facility)* $_{Obj}$ *(to the customer)* $_{Dest}$ *’*
Means	*Means* (Mea) designates an entity which acts as an instrument using which a goal is to be performed.	*Offer (booking facility)* $_{Res}$ *(to customers)* $_{Dest}$ *(with Internet booking system)* $_{Mea}$
Manner	The *manner* (Man) defines the way in which the goal is achieved.	*‘Check (availability)* $_{Obj}$ *(in a real time process)* $_{Man}$ *’*
Beneficiary	The *beneficiary* (Ben) is the person (or group of persons) in favour of whom the goal is achieved.	*‘Reduce (work load)* $_{Obj}$ *(for the hotel staff)* $_{Ben}$ *’*
Referent	The *Referent* (Ref) is the entity with regard to which an action is performed, or a state is attained or maintained.	*‘Adjust(price)* $_{Obj}$ *(to inflation rate)* $_{Ref}$ *’*
Quality	The *quality* (Qual) defines a property that has to be attained or preserved.	*‘Remain(more reliable)* $_{Qual}$ *(than our competitors)* $_{Ref}$ *’*
Location	The *Location* (Loc) situates the goal in space. This case implies no movement, or movement within the same location.	*‘Make (room booking)* $_{Res}$ *(in a travel agency)* $_{Loc}$ *’*
Time	The *Time* (Time) situates the goal in time.	*‘Remove (option booking)* $_{Obj}$ *(after 8 days)* $_{Time}$ *’*
Quantity	*Quantity* (Quan) quantifies an evolution that should occur	*‘Reduce(price)* $_{Obj}$ *(by 3%)* $_{Quan}$

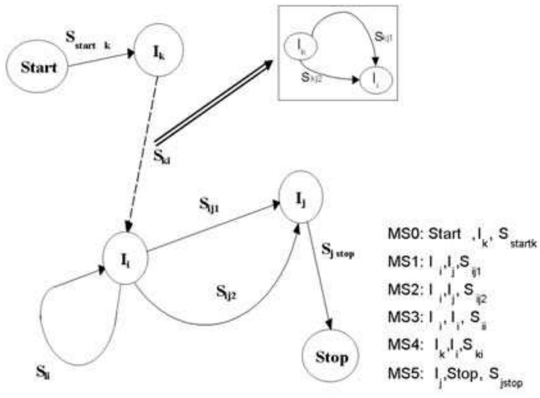

Fig. 2. The map as a graph

There are three relationships between sections (Fig. 4), namely *thread*, *path* and *bundle* which generate *multi-thread* and *multi-path* topologies in a map.

- *Thread relationship*: It is possible for a target intention to be achieved from a source intention in many different ways. Each of these ways is expressed as a section in the map. Such a map topology is called a *multi-thread* and the sections participating in the multi-thread are said to be in a *thread relationship* with one another. MS1 and MS2 are in a thread relationship in Fig. 2. Assume that *Accept Payment* is another intention in our example and that it can be achieved in two different ways, *By electronic transfer* or *By credit card*. This leads to a thread relationship between the two sections shown in Fig. 3.

It is clear that a thread relationship between two sections regarded as facets represents directly the variability associated to a multi-facetted purpose. Multi-faceting is captured in the different strategies to achieve the common target intention.

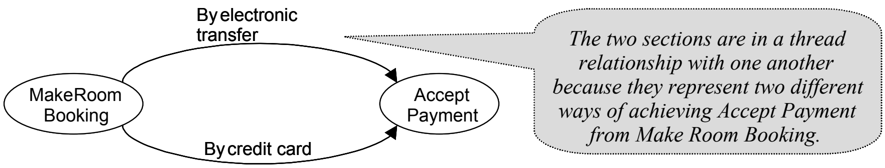

Fig. 3. An example of thread relationship

- *Path relationship*: This establishes a precedence/succession relationship between sections. For a section to succeed another, its source intention must be the target intention of the preceding one. MS0, MS1, MS4, MS5 is a path of the map in Fig. 2. In Fig. 4, the two sections <*Start, Make Room Booking, On the Internet*>, <*Make Room Booking, Accept Payment, By credit card*> form a path.

From the point of view of modeling facets, the path introduces a composite facet whereas the section based facet is atomic.

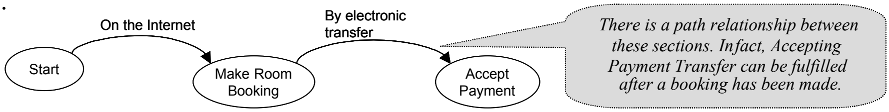

Fig. 4. An example of path relationship**.**

Given the thread and the path relationships, an intention can be achieved by several combinations of sections. Such a topology is called a *multi-path*. In general, a map from its *Start* to its *Stop* intentions is a multi-path and may contain multi-threads. Let us assume in our example that it is possible to *Stop* either because a customer retracts from making the booking (*By customer retraction*) or after payment (*Normally*). Fig. 5 shows the entire map with the purpose to *Make Confirmed Booking*. This map contains several paths from Start to Stop out of which two forming a multi-path are highlighted in Fig. 5.

Clearly, the multi-path topology is yet another way of representing the multi-facetted perspective. Multi-faceting in this case is obtained by combining various sections together to achieve a given intention of the map. Consider for instance the intention Accept payment in Fig. 5; there are four paths from Start to achieve it; each of them is a different way to get the intention achieved and in this sense, participates to the multi-faceting. Each path is a composite facet composed of two atomic facets. This can be extended to the full map which can be seen as composed of a number of paths from Start to Stop. This time these paths introduce multi-faceting but to achieve the intention of the map which in our example, is Make Confirmed Booking.

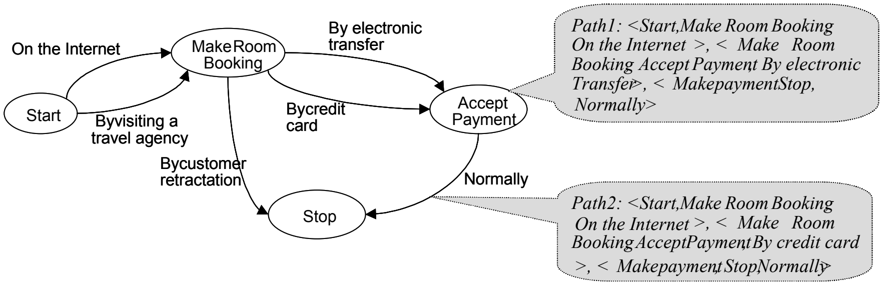

Fig. 5. The multi-path of the map Make Confirmed Booking

- *Bundle relationship*: A section that is a bundle of other sections expresses that only one of its sections can be used in realizing the target intention. Consider *Make Room Booking* and *Accept Payment* once again. Let it be that the hotel has entered into an agreement with an airline to provide rooms against miles earned by passengers. Accordingly, payment is accepted either normally or (exclusive) from the airlines miles. Notice that the difference between a thread and bundle relationship is the exclusive OR of sections in the latter versus an OR in the former.

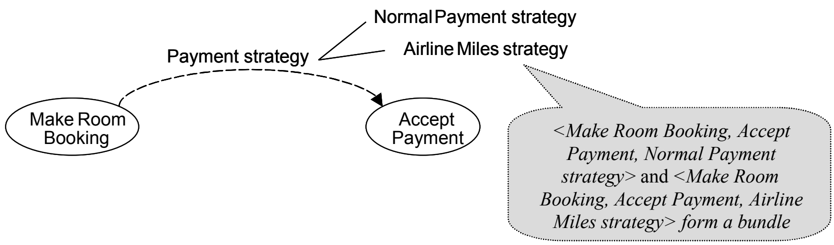

Fig. 6. The bundle relationship

- Fig. 4 also shows that a section of a map can be refined as another map through the *refinement relationship*. The entire refined map then represents the section as shown in Fig. 7. Refinement is an abstraction mechanism by which a complex assembly of sections at level $i+1$ is viewed as a unique section at level i. As a result of refinement, a section at level i is represented by multiple paths & multiple threads at level $i+1$.

From the point of view of multi-faceting, refinement allows to look to the multi-facetted nature of a facet. It introduces levels in the representation of *the multi-facetted purpose which is thus, completely modelled through a hierarchy of maps.*

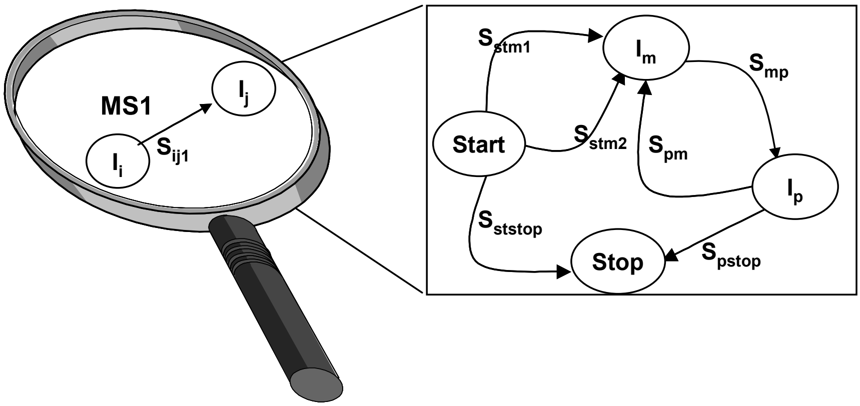

Fig. 7. The refinement relationship

To sum up a)The purpose of the artefact is captured in a *hierarchy of maps*. The intention associated to the root map is the high level statement about the purpose. Using the refinement mechanism each section of the root map can be refined as a map and the recursive application of this mechanism results in a map hierarchy. At successive levels of the hierarchy the purpose stated initially as the intention of the root map is further refined.
b)At any given level of the hierarchy, the multi-facetted dimension is based on *multi-thread* and *multi-path* topologies. Multi-thread introduces local faceting in the sense that it allows to represent the different ways for achieving an intention directly. Multi-path introduces global faceting by representing different combinations of intentions and strategies to achieve a given map intention. Any path from Start to Stop represents one way of achieving the map intention, therefore the purpose represented in this map.

Comparing Map with other goal modeling approaches

As process models, maps can be compared to the various types of process modelling languages and formalisms that have emerged supporting a variety of purposes. The existing formalisms can be roughly classified according to their orientation to activity-sequence oriented languages (e.g., UML Activity Diagram), agent-oriented languages (e.g., Role-Activity Diagram

[27]), state-based languages (e.g. UML state charts), intention-oriented languages (e.g. Maps).

The concept of goal is central in business process modelling and design. It is included in many definitions of business processes (e.g. "a business process is a set of partially ordered activities aimed at reaching a goal" [15]. However, most process modelling languages do not employ a goal construct as an integral part of the model. This is sometimes justified by viewing these models as an "internal" view of a process, focusing on *how* the process is performed and externalising *what* the process is intended to accomplish in the goal [7].

In contrast, intention-oriented process modelling focuses on what the process is intended to achieve, thus providing the rationale of the process, i.e. *why* the process is performed. Intention-oriented process modelling such as *Map*, follows the human intention of achieving a goal as a force which drives the process. As a consequence, goals to be accomplished are explicitly represented in the process model together with the alternative ways for achieving them, thus allowing variability in goal achievement to be modelled and facilitating the selection of the appropriate alternative for achieving the goal at enactment time.

3 Illustrating the use of *Map*

In this section we show the use of the *Map* representation system to capture the multi-facetted purpose of a system and take the financial information system of DIAC, the financial branch of Renault to illustrate this.

3.1 The DIAC Context

The DIAC company aims to sell products for financing the purchase of Renault vehicles. These are loans and leases. Business processes are organized into sales and post-sales administration. Sales processes include the definition of catalogues of products and contracting customers. Post-sales processes include treasury and information flow management. DIAC has a number of subsidiaries in different countries in Europe which have developed their own processes and their own information systems to support these activities.

The objective of the project was to standardize both the business processes and the supporting information systems across Europe. The DIAC headquarters in Paris were leading the project but the Spanish information system was selected as the basis for adaptation and further deployment in France, Spain, Portugal and Germany in a first stage. There were new business needs as well : (a) diversification of the sales channels to include for example, sales by the Internet in addition to regular vendors, (b) inclusion of additional financial services such as offering personal loans in addition to car loans, and (c) introducing a customer centric culture to replace the current contract centric one.

Our mission in the project was twofold (a) to help DIAC stakeholders capturing the intentionality behind the future DIAC business and supporting information system with maps and (b) to derive the information system specifications from these maps. In the following, we illustrate the use of *Map* as part of activity (a).

3.1.1 The Maps Construction Process

We were typically faced to a *system adaptation* problem bounded by the following constraints:

- No large scale deviations from the selected software system (the Spanish information system)
- Compliance with some of the functionality not found in the selected system but provided by others (the French system)
- Provision of functionality for handling the new business opportunities that were now recognized to be important.

From the foregoing it seemed to us that the adaptation process should be driven by *gaps* which identify what has to be changed/adapted to the new situation. In this change context, it is not so much the representation of the future situation that is important but the difference with the current situation. If gaps remain implicit, it is difficult to identify what has to be changed. Explicit gap representation seems to us, therefore, crucial to expressing change requirements. We developed a *gap typology* adapted to *maps* and organized the process for eliciting gaps between the As-Is situation and the To-Be situation as an iterative one as follows:

Repeat till all maps have been considered

1. Construct the *As-Is map* (if it does not exists yet)
2. Construct the To-Be by difference with the As-Is map taking into account the target selected system and the organization requirements for change. The *To-Be map* and the *Gaps* are modelled concurrently and then, documented,
3. Deliberate on each section of the To-Be map to decide if further refinement is required to identify more detailed gaps or not. Every section marked as '*to-be-refined'* will serve as starting point for a new

iteration of the elicitation process. Every section that does not require refinement gets the ‘green’ status.

The three steps were carried out in a *participative* manner. This allowed the consideration of different view points with the aim of reconciling them co-operatively, in the construction of the As-Is and To-Be maps as well as in the elicitation of gaps. Additionally, in step 3, the decision to refine elicited gaps at an iteration was also made co-operatively. As before, the refinements committed to in this step emerge as a consensus from among the different view points.

3.1.2 The Top Level Map

In its totality, the DIAC business and system can be seen to meet the purpose*, Satisfy Financial Needs of Renault Vehicle buyers Efficiently.* This is the intention of the root map shown in Fig. 8. The map shows that to meet this purpose three intentions have to be achieved, namely *Offer a product*, *Gain the customer,* and *Manage the customer relationship*. Evidently, there is an ordering between these intentions: the company cannot gain customers unless it offers products and it needs to maintain the customer relationships to be reimbursed of the customers’ loans and pursue business with them.

The map of Fig. 8 shows a number of paths from *Start* to *Stop* that are constructed over 14 facets named C1 to C14 in the Figure. Thus, the map is able to present a global perspective of the diverse ways of achievement of the main purpose. When a more detailed view is needed, then it becomes necessary to focus more specifically on the multi-facetted nature of each intention found in the ‘global’ map. The detailed view of the intentions contained in Fig. 8 is brought out in turn below.

The multi-facetted nature of *Gain the customer* is shown in Fig. 8 by including three strategies for its achievement (a) *By prescribing* products it offers, (b) *By prospecting* new customers and (c). *By securing the customer loyalty*. The three facets are *<Offer a product,, Gain the customer, By prescribing>*, *<Offer a product,, Gain the customer, By prospecting>*, *and <Manage the customer relationship, Gain the customer, By securing the customer loyalty >.* Whereas the first of these three facets corresponds to a well established business strategy, the other two are novel. *By securing the customer loyalty* supports the company's essential requirement to keep customers as long as there is no need to *Stop* financing them *by exclusion*. It is completely innovating compared to the As-Is business model.

The intention of *Managing the customer relationship* is initiated *By demanding of the transfer* of the contracts signed with the pre-sales department to the post-sales administration. In DIAC's vision of the future way to hold the business, “customer relationship” means having business dealings with, and for customers. The intention name was thus introduced to emphasize a determining gap with the contract-wise management of customers currently prevailing in France and Spain. The customer relationship management requires, first of all, a unified handling of all contracts for a given customer. This corresponds to a change of culture for the company and an important change in the information system data structure and functionalities.

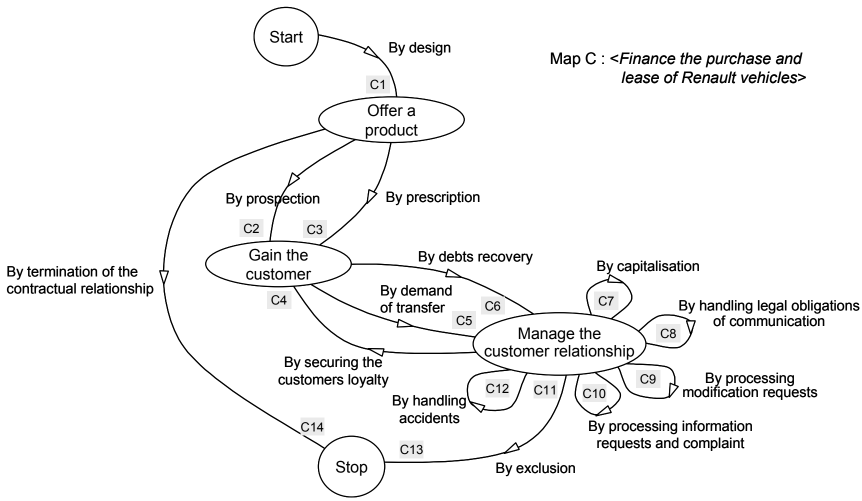

Fig. 8. Top level To-Be map of DIAC

As shown in Fig. 8, there are a number of different strategies to *Managing the customer relationship*. This multi-faceting highlights the new emphasis put by DIAC on the achievement of this intention in a set of diverse ways. Managing the relationship with customers should be done *By debts recovery* according to the contracts repayment schedules, and by managing multiple flows of customer-related information. This is shown in the map by the strategies: *By processing modification requests*, *By processing information and complaints requests*, and *By handling legal obligations of communication*. The latter strategy is imposed by the European and national laws on information privacy. Managing the customer relationship *By capitalization* of treasury, is an absolute requirement to ensure forthcoming financing. The strategy *By handling accidents* is important as well as, for some products, DIAC may propose to pay in the place of customers who have suffered damages that stop them to reimburse their debts.

4 Conclusion

The thrust of this chapter is to embedding systems in their larger usage context that is made possible by stepping back from merely anticipating the functionality that a system must provide (as done in conceptual modelling) to the determination of this functionality in a systematic manner. This is done by identifying the aims and objectives of different stakeholders and the activities they carry out to meet these objectives. The goal driven approaches that support this view lead to better understand the purpose behind the system To-Be and therefore, to more easily accepted systems in organizations.
The belief of the author is that goal-driven approaches are now facing the challenge of forthcoming multi-purpose systems, i.e. systems that incorporate variability in the functionality they provide and will be able to self adapt to the situation at hand. The goal/strategy maps have been introduced and discussed as an example of goal model that has been conceived to meet the aforementioned challenge.

A map expression provides a synthetic view of the variability of a system in a relatively easy to understand way. Variations are revealed in two ways, by the gradual movement down the different levels of a top map, and by the alternative strategies/paths available at a given map level. Variations express the multi purpose behind systems. Their expression relates more closely to the organizational stakeholders as different from system developers. Yet, this expression acts as a specification of what the new system should achieve.

Maps have been used in large scale industrial projects and in different areas such as business process modeling [25,33], change management [26, 37] , system evolution handling [36, 39], installation of ERP systems [30, 31, 45], process/system alignment [10, 40] and more recently in service definition and composition [18].

Finally, it is clear that the map needs to be supported by (a) a guidance mechanism that systematically helps the dynamic construction of maps, their verification and documentation and (b) an enactment mechanism that would present the different choices available for achieving an intention and aid in selecting one or more of these. These form the topic of current work.

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